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AN INSTRUMENT TO MEASURE STREAM CHANNEL GRADIENT AND PROFILES

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ABSTRACT

A waterlevel to measure streambed profiles and gradients is described. Line of sight is not required for accurate (to 1 cm) measurements. Assembly and use are discussed.

KEYWORDS: Measuring equipment, channel erosion.

Stream channel morphometry and gradient are important factors in determining the quality of salmonid habitat. Although several methods are available to measure profiles and gradients, they require line of sight and are frequently cumbersome in small stream measurements. We adopted a builders level to measure gradients and channel profiles, which eliminates many of the requirements of other methods.

The instrument is easy to use, inexpensive, and simple to build. Based on the principle that water seeks its own level, it is precise and accurate to 1 cm. The instrument we describe will measure a vertical drop up to 1 m. Larger drops and distances can be measured by constructing a larger instrument than the one described here.

The waterlevel (fig. 1) is constructed from a pair of 2-m x 1/2-in[1] type "L" or "M" copper water pipes, a pair of 1-m x 1/2-in O.D., 1/4-in I.D. plastic tubes, pipe fittings, and 1/4-in flexible plastic tubing. Each pipe is cut into a 1-m upper scale assembly section and a 1-m lower support section. The scale assembly receives the scale and the clear plastic pipe. The scale assemblies are prepared by removing two thirds of the diameter of 1-m length of each pipe with a table saw. Use a non-ferrous cutting blade and the fence set to guide the pipe.[2] The finished pipe is cleaned with a file to remove all sharp edges.

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[1]English measurements are used to correspond to commonly available materials on the U.S. market.

[2]Caution: A face shield and heavy gloves should be worn during this operation. The cutting generates heat and metal chips; and until filed, the cut edges are very sharp.

Figure 1.--The waterlevel device.

We used a calcomp plotter to draw the 1-m scale strip in 1-cm increments from 0 to 100 cm on waterproof mylar paper. The strip is placed inside the 1-m opening cut out of the copper pipe.

We sealed the scale strip between the clear plastic tube and the open copper pipe with a clear leak-tight sealer to maintain a closed water system inside the pipe and tube. The pipe and tube are clamped together until the sealer is set. Enough sealer should be used to insure a good bond between components. Excess sealer is easily removed from the face of the scale sight tube.

The scale assembly (1) is soldered into a tee connection (2) (fig. 2). A 1/2-in sweat to a 3/4-in NPT (National Pipe Thread) fitting (3) is soldered into the tee. A 3/4-in to 1/4-in NPT bushing (4) is connected to the 3/4-in NPT fitting. A 1/4-in thermoplastic tube fitting is mounted in the 1/4-in NPT bushing (5). The thermoplastic fitting is fitted with a short length of 1/4-in polyethylene tubing (6). The two level tubes are connected with a length of 1/4-in I.D. flexible plastic tubing. The length is optional, but we use a 10-m length. The flexible tubing is clamped onto the polyethylene tubing. The lower copper support section is sealed water tight and connected to the lower opening of the tee fitting. A threaded adapter between the tee and the support allows the two sections to be separated for transportation and storage.

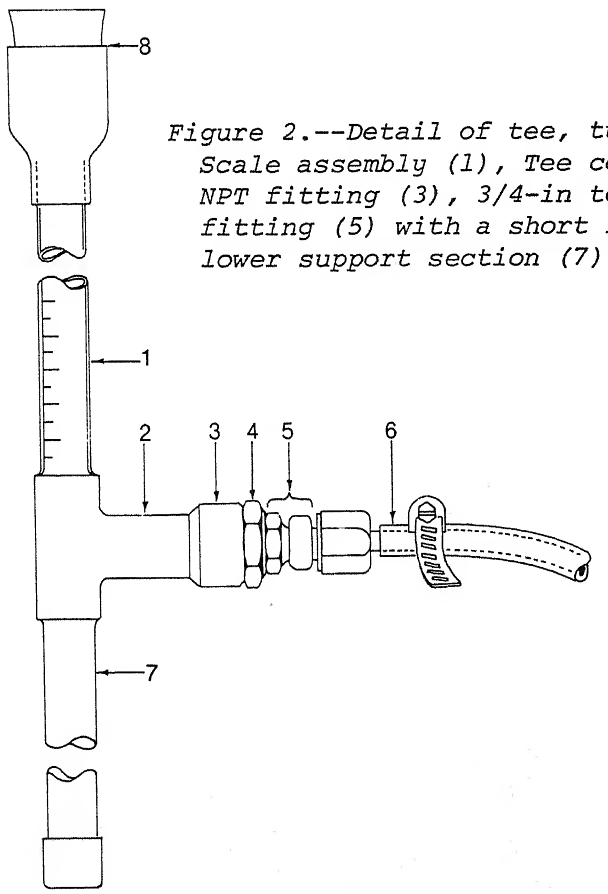

Figure 2.--Detail of tee, tubing connection, and top of waterlevel. Scale assembly (1), Tee connection (2), 1/2-in sweat to 3/4-in NPT fitting (3), 3/4-in to 1/4-in NPT bushing (4), thermoplastic fitting (5) with a short length of 1/4-in polyethylene tubing (6), lower support section (7), top fitted with a rubber stopper (8).

Both scale tubes must be the same height when finished so readings will be the same when the water tube assembly is vertical. Care must be taken to insure that all parts are made the same length and the scale strips are matched for each pair of scale tubes.

The water level system is filled with water to 40 or 50 centimeters on both sight tubes with both tubes held vertically on the same level. The water filled tubes must be free of air bubbles. An uneven water level indicates air bubbles, plugged or restricted tubes, or stoppers left in the top of the level tube. Stoppers are placed in the reducers (8) in the top of each level tube after filling and are removed during use (fig. 2). The connecting tube may be coiled for transportation to the stream site.

To calculate gradient, the horizontal distance (d) and the vertical drop (v) must be measured. The length of the flexible plastic tube represents horizontal distance (d), and the difference between the water level in the two scales h_1 and h_2 represent vertical drop (v). For example, let d = 10 m, the downstream reading h_1 = 87 cm, and the downstream reading h_2 = 17 cm, then gradient in percent (g) can be calculated from the general equation:

$$g = \frac{(h_1 - h_2)}{d_{cm}} \text{ X } 100$$

$$\text{where } d_{cm} = d \text{ X } 100$$

In the above example the gradient is 7.0 percent.

Stream cross-sections are measured in the same manner, but the water level on the bank (reference station) will change as the depth across the transect changes because there is a constant volume of water in the tube (fig. 3). The difference between the two readings is the vertical drop from the streambank to the stream bottom h_i (fig. 3). Let y = reference station reading, x = transect station reading, h = actual depth with respect to the reference station, and i = transect point. For the first transect point depth (h_i, i = 1) take both readings on the bank. At this point $x_i - y_i = 0$; thereafter $h_i = x_i - y_i$.

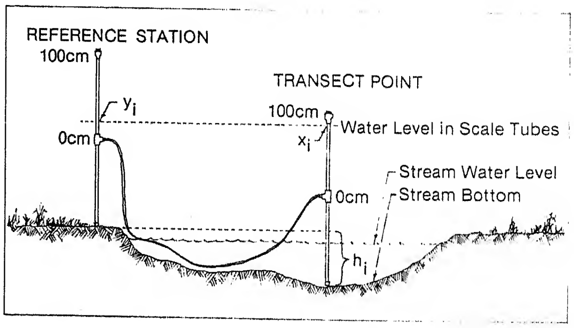

Figure 3.--Stream channel cross-section showing operation of a waterlevel device to measure channel profile.

The stoppers should be replaced to prevent water loss during transportation. After the stoppers are removed, the water will oscillate for a few seconds. Oscillations are also set up if the flexible tube is placed in a turbulent current. Readings can be taken with the tubing over, under, and around obstructions, even if the tubing is higher than the sight tubes. Line of sight is not necessary. The limit for vertical drop to be measured is 1 m.

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